PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04J 3/16, H04B 7/26 // H04Q 7/22

A1

(11) International Publication Number: WO 96/27959

(43) International Publication Date: 12 September 1996 (12.09.96)

(21) International Application Number: PCT/FI96/00134

(22) International Filing Date: 6 March 1996 (06.03.96)

(30) Priority Data:
951019 6 March 1995 (06.03.95) FI

(71) Applicant (*for all designated States except US*): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI).

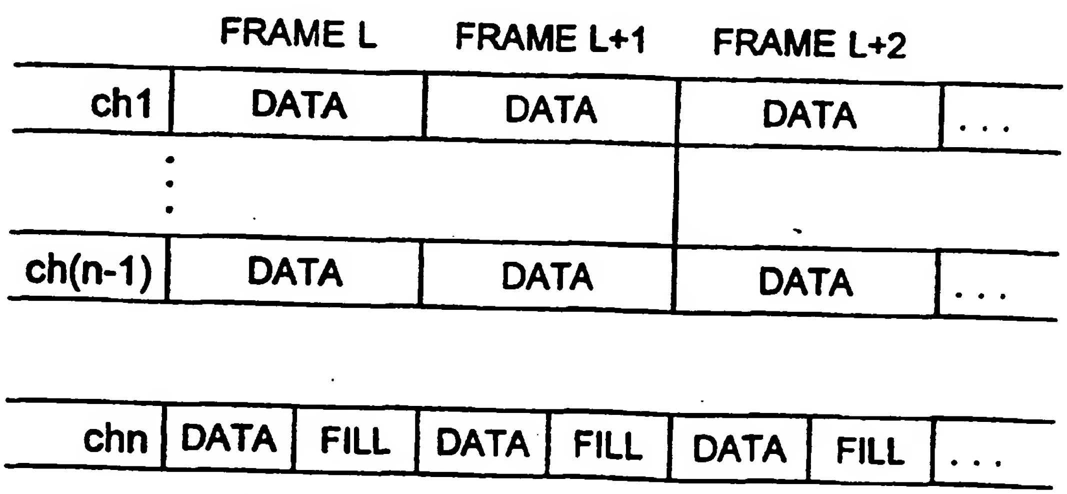
(72) Inventor; and
(75) Inventor/Applicant (*for US only*): RÄSÄNEN, Juha [FI/FI]; Pensaskertuntie 8 A, FIN-02660 Espoo (FI).

(74) Agent: OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: HIGH-SPEED DATA TRANSMISSION IN MOBILE COMMUNICATION NETWORKS



(57) Abstract

The invention relates to a digital mobile system and a method for high-speed data transmission in a digital mobile system. The mobile network allocates n parallel rate-adapted traffic channels to a high-speed user data signal which requires a data transfer rate R_{user} within a range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of a single traffic channel. The user data signal is divided in the transmitter into transmission frames (L, L+1, L+2) for transmission via the parallel traffic channels (ch1-chn) in such a way that all the information bits in the transmission frames of n-1 traffic channels carry user data bits (DATA), and the user data transfer rate of each of the n-1 traffic channels is R_{ch}. In the frames of the nth traffic channel (chn) the number of the information bits carrying user data bits (DATA) is selected to correspond to the user data rate $R_{user}-(n-1)*R_{ch}$ exceeding the capacity of the other n-1 traffic channels. The remaining information bits in the frames of the nth traffic channel carry stuff bits (FILL).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia
AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgystan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakhstan
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam

High-speed data transmission in mobile communication networks

Field of the Invention

The invention relates to high-speed data transmission in digital mobile communication networks.

Background of the Invention

In telecommunication systems of the time division multiple access (TDMA) type, the communication on the radio path is time-divisional and occurs in successive TDMA frames each of which consists of several time slots. A short information packet is transmitted in each time slot in the form of a radio-frequency burst that has a limited duration and that consists of a number of modulated bits. The time slots are primarily used for conveying control and traffic channels. The traffic channels are used for transferring speech and data. The control channels are for signalling between a base station and mobile stations. An example of a TDMA radio system is the Pan-European digital mobile system GSM (Global System for Mobile Communications).

In conventional TDMA systems, one traffic channel time slot is allocated for communication to each mobile station for the transmission of data or speech. For example the GSM system may therefore comprise as many as eight parallel connections to different mobile stations on a radio frequency carrier. The maximum data transfer rate on one traffic channel is limited to a relatively slow level, e.g. in the GSM system 9.6 Kbps or 12 Kbps, according to the available bandwidth and the channel coding and error correction employed in the transmission. In the GSM system, a so-called half-rate (max. 4.8 Kbps) traffic channel can also be selected for low speech coding rates. The half-rate traffic channel is established when a mobile station operates in an

assigned time slot only in every other frame, i.e. at half the rate. Another mobile station operates in the same assigned time slot of every other frame. The system capacity, measured in the number of mobile subscribers, can thus be doubled, i.e. as many as 16 mobile stations can operate on the carrier frequency simultaneously.

In recent years, the need for high-speed data services in mobile networks has increased considerably. For example transmission rates of at least 64 Kbps would be required for the ISDN (Integrated Services Digital Network) circuit-switched digital data services. The data services of the public switched telephone network (PSTN), for example a modem and G3-type telefax terminals, require higher transmission rates such as 14.4 Kbps. One of the increasing areas of mobile data transmission that requires transmission rates exceeding 9.6 Kbps is mobile video services. Examples of such services include security surveillance by means of cameras, and video databases. The minimum data rate in video transmission may be for example 16 or 32 Kbps.

The transmission rates of the present mobile networks are not sufficient for meeting these new requirements, however.

An arrangement, which is disclosed in a co-pending patent application of the Applicant, WO95/31878 (unpublished on the filing date of the present application), relates to allocating two or more parallel traffic channels (subchannels) on the radio path for one high-speed data connection. The high-speed data signal is divided in the transmitter into these parallel subchannels for the transmission over the radio path, to be restored in the receiver. This approach enables the supply of data transmission services with as high as eight-fold transmission rate compared to the conventional rate, depending on the number of the

traffic channels allocated. For example in the GSM system, the total user data rate of 19.2 Kbps is obtained by two parallel 9.6 Kbps subchannels, each channel being rate-adapted in the same manner as in the existing transparent 9.6 Kbps bearer services of the GSM system.

A problem relating to the use of parallel traffic channels is the data rates which cannot be rate-adapted with the existing methods of the GSM system even though these data rates can be evenly distributed between the available parallel subchannels.

For example the user data rate of 14.4 Kbps (according to e.g. ITU-T Recommendation V.32bis) requires two transparent GSM traffic channels the data rate in each of which should be 7.2 Kbps (2 × 7.2 Kbps = 14.4 Kbps), but there is no rate adaptation in the GSM system for the subchannel data rate of 7.2 Kbps.

Correspondingly, for example the user data rate of 40 Kbps (ITU-T Recommendation V.120) requires five transparent GSM traffic channels in each of which the data rate should be 8 Kbps (40 Kbps : 5), but there is again no rate adaptation in the GSM system for such a subchannel data rate.

Another problem is the data rates that cannot be evenly divided into a required number of transparent GSM traffic channels. For example the user data rate of 56 Kbps (ITU-T Recommendation V.110) requires at least six transparent GSM traffic channels, but it cannot be divided into these six parallel subchannels in such a way that the (V.110) frames of each subchannel carry the same number of data bits (56 Kbps : 6 = 9333.333 bps).

Disclosure of the Invention

An object of the present invention is to provide a method and a telecommunication system which support the rata adaptation of different transmission

rates in high-speed data transmission utilizing parallel traffic channels.

A first aspect of the invention is a method for high-speed data transmission in a digital mobile communication system, said method comprising a step of

transmitting data over the radio path between a mobile station and a fixed mobile network on a rate-adapted traffic channel allocated to the mobile station. According to the invention, the method is characterized by further steps of

allocating n parallel rate-adapted traffic channels to a high-speed user data signal, which requires a data rate R_{user} within a range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of any one of said traffic channels, and n=2,3,...,

dividing the high-speed user data signal into transmission frames for transmission via said parallel traffic channels in such a way that all the information bits in the transmission frames of n-1 traffic channels carry user data bits, and the user data transfer rate of each of said n-1 traffic channels being R_{ch}, and a number of the information bits carrying user data bits in transmission frames of said nth traffic channel corresponds to the user data transfer rate $R_{user}-(n-1)*R_{ch}$ left over from the other n-1 traffic channels, and the remaining information bits in the transmission frames of said nth traffic channel carry stuff bits.

A second aspect of the invention is a digital mobile communication system wherein a mobile station and a fixed mobile network comprise a data transmitter and a data receiver which are capable of data transmission over the radio path on a traffic channel allocated to the mobile station. According to the invention, the system is characterized in that

the fixed mobile network is arranged to allocate n parallel rate-adapted traffic channels to a high-speed user data signal which requires a data transfer rate R_{user} that is in the range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of an individual traffic channel and $n=2,3,...,$

the data transmitters are arranged to divide the high-speed user data signal into transmission frames for transmission via said parallel traffic channels in such a way that all the information bits in the transmission frames of n-1 traffic channels carry user data bits, and the user data transfer rate of each of said n-1 traffic channel being R_{ch}, and a number of the information bits carrying user data bits in the transmission frames of the nth traffic channel corresponds to the user data transfer rate $R_{user}-(n-1)*R_{ch}$ left over from the other n-1 traffic channels, and the remaining information bits in the transmission frames of said nth traffic channel carry stuff bits.

According to the present invention, if a high-speed user data signal requires the capacity of n traffic channels, the user data is divided into traffic channels in such a way that the capacity of n-1 traffic channels is used completely, i.e. each information bit in each transmission frame carries user data. The remainder of the user data (the user data exceeding the capacity of n-1 channels) is carried in a required number of information bits of the frames on the nth traffic channel. The remaining "extra" information bits on the last-mentioned traffic channel carry stuff bits.

Therefore the transmission frames of all traffic channels contain a fixed number of information bits independently of the data rate of the high-speed signal to be transmitted. The number of the information bits is such that the data rate of the frame is fixed

and corresponds to the standard rate adaptation of a traffic channel in the mobile communication system, e.g. 9.6 Kbps in the GSM system. Due to the invention, all user transmission rates that have already been and that will be standardized can be transferred via mutually identical traffic channels that have been rate-adapted to one transmission rate, by performing a further rate adaptation within a single traffic channel. The rate adaption of a high-speed user data signal requires changes in the frames of only one traffic channel, and these changes concern the selection of the relative proportion of user data bits and stuff bits to correspond to the transmission rate that is left over from the other traffic channels. The other parallel traffic channels carry a full amount of user data and are therefore completely standard rate-adapted traffic channels.

For example in the GSM system, it is possible to use a standard 9.6 Kbps rata-adapted transparent traffic channel and a transmission frame of 48 information bits according to the CCITT Recommendation V.110. In such a case, different user data rates between 0 and 9.6 Kbps can be transmitted through a 9.6 Kbps rate-adapted traffic channel by varying the number of the information bits used for the user data transmission between 0 and 48 in the V.110 frame.

The centralization of stuff bits in one traffic channel enables the transmission at any standard data rate. Distributing the user data bits and the stuff bits evenly into traffic channels would not be possible with all standard transmission rates, such as 56 or 64 Kbps, but "fragments" of bits would have to be transmitted in the frames. In practice, this would require a long user data buffer in the transmission. In the invention, a fixed number of user data bits and stuff bits are

transmitted even on the last traffic channel, wherefore no separate buffering is needed and the above-described problem is not encountered.

Brief Description of the Drawings

In the following, the invention will be described by means of preferred embodiments with reference to the accompanying drawings, in which

Figure 1 illustrates a part of a mobile system wherein the invention can be applied,

Figure 2 illustrates high-speed data transmission in two TDMA time slots over the radio path,

Figure 3 illustrates the network architecture according to the invention, which supports the high-speed data transmission of several traffic channels between a mobile station MS and an interworking function IWF in the GSM system,

Figure 4 shows the V.110 frame structure,

Figure 5 illustrates the data transmission according to the invention in the frames of n parallel traffic channels,

Figure 6 illustrates the adaptation of the user rate of 56 Kbps to six 9.6 Kbps traffic channels according to the invention.

Preferred Embodiments of the Invention

The present invention may be applied to high-speed data transmission in digital TDMA-type mobile communication systems, such as the Pan-European digital mobile communication system GSM, DCS1800 (Digital Communication System), the mobile communication system according to the EIA/TIA Interim Standard IS/41.3, etc. The invention will be illustrated below by using as an example a GSM-type mobile system, without being restricted thereto, however. Figure 1 introduces very briefly the basic structural components of the GSM system, without describing their characteristics or the

other elements of the system. For a more detailed description of the GSM system, reference is made to the GSM recommendations and to *"The GSM System for Mobile Communications"* by M. Mouly and M. Pautet (Palaiseau, France, 1992, ISBN:2-9507190-07-7).

A mobile services switching centre controls the switching of incoming and outgoing calls. It performs similar functions as the exchange of the PSTN. Further, it also performs, together with the network subscriber registers, functions, such as location management, that are only characteristic of mobile telephone traffic. Mobile stations MS are connected to the MSC via base station systems BSS. A base station system BSS consists of a base station controller BSC and base stations BTS. For the sake of clarity, Figure 1 only shows a base station system wherein two base stations are connected to the base station controller BSC and wherein one mobile station MS is located within the coverage area of the base stations.

The GSM system is a time d ision multiple access (TDMA) type system. The channel structures used in the radio interface are defined in greater detail in the ETSI/GSM recommendation 05.02. During normal operation, one time slot is allocated from a carrier frequency to a mobile station MS as a traffic channel in the beginning of a call (single slot access). The mobile station MS is synchronized with the allocated time slot to transmit and receive radio-frequency bursts. During the remaining time of the frame, the MS performs different measurements. The Applicant's co-pending patent applications WO95/31878 and PCT/FI95/00673 disclose a method wherein two or more time slots are allocated to a mobile station MS which requires data transmission with a higher rate than what one traffic channel can provide. As regards the details of this

procedure, reference is made to the aforementioned patent applications.

In the following, the procedure will be described with reference to Figure 2 only as one way of carrying out high-speed data transmission, based on several parallel traffic channels, in a radio system. It should be noted, however, that the only matter essential for the invention is that a connection comprising several parallel traffic channels is established, and the invention itself relates to carrying out and synchronizing data transmission over such a connection.

Figure 2 shows an example wherein successive time slots 0 and 1 are allocated to a mobile station MS from a single TDMA frame. A high-speed data signal DATAIN, which is to be transmitted over the radio path, is divided in a divider 82 into a required number of lower-speed data signals, namely DATA1 and DATA2. Each lower-speed data signal DATA1 and DATA2 is separately subjected to channel coding, interleaving, burst formation and modulation 80 and 81, respectively, whereafter each lower-speed data signal is transmitted as a radio-frequency burst in a dedicated time slot 0 and 1, respectively. When the lower-speed data signals DATA1 and DATA2 have been transmitted over the radio path through different traffic channels, they are separately subjected in the receiver to demodulation, deinterleaving and channel decoding 83 and 84, respectively, whereafter the signals DATA1 and DATA2 are again combined in a combiner 85 of the receiver into the original high-speed signal DATAOUT.

Figure 3 is a block diagram illustrating the GSM network architecture which implements such data transmission using several parallel traffic channels. The functions of the blocks 80, 81, 83 and 84 of Figure

3, i.e. channel coding, interleaving, burst formation and modulation, and correspondingly demodulation, deinterleaving and channel decoding are situated on the side of the fixed network preferably at the base station BTS. The above-described TDMA frame is thus transmitted between the base station BTS and the mobile station MS in a radio interface Radio I/F. Each time slot is subjected to separate parallel processing at the base station BTS. The divider 82 and the combiner 85 of Figure 2 may be located in the fixed network side remote from the base station BTS in another network element, such as BSC, whereupon the lower-speed data signals DATA1 and DATA2 are transmitted between this network element and the base station in the same way as the signals of normal traffic channels. In the GSM system, this communication takes place in TRAU frames according to the ETSI/GSM recommendation 08.60 between the base station BTS and a special transcoder/rateadapter unit (TRCU). The TRAU frames and the transmission associated thereto are not essential for the invention, since the invention relates to carrying out and synchronizing data transmission over the entire data connection utilizing several parallel traffic channels, i.e. between the divider 82 and the combiner 85.

In the GSM system, a data link is formed between a terminal adapter 31 in the mobile station MS and an interworking function IWF 32 in the fixed network. In data transmission occurring in the GSM network, this connection is a V.110 rate-adapted, UDI-coded digital 9.6 Kbps full-duplex connection that is adapted to V.24 interfaces. The V.110 connection described herein is a digital transmission channel that was originally developed for ISDN (Integrated Services Data Network) technology, that is adapted to the V.24 interface, and that also provides the possibility of

transmitting V.24 statuses (control signals). The CCITT recommendation for a V.110 rate-adapted connection is disclosed in the CCITT Blue Book: V.110. The CCITT recommendation for a V.24 interface is disclosed in the CCITT Blue Book: V.24. The terminal adapter 31 adapts the data terminal connected to the mobile station MS to a V.110 connection, which is established over a physical connection utilizing several traffic channels ch0 to chN. The IWF couples the V.110 connection to another V.110 network, such as an ISDN or another GSM network, or to some other transit network, such as the public switched telephone network PSTN. In the first case, the IWF only contains the divider/combiner 82/85 according to the invention. In the last-mentioned case, the IWF also contains for example a baseband modem by means of which data transmission is performed through the PSTN.

The frame structure used for data transmission on a V.110 connection (9.6 Kbps) is shown in Figure 4. The frame comprises 80 bits. Octet 0 contains binary zeroes, whereas octet 5 contains a binary one which is followed by seven E bits. Octets 1 to 4 and 6 to 9 comprise a binary one in bit position 1, a status bit (S or X bit) in bit position 8, and 6 data bits (D bits) in bit positions 2 to 7. The bits are transmitted from left to right and from top to bottom. The frame thus comprises 48 information bits D1 to D48 (user data). Bits S and X are used to transmit channel control information associated to the data bits in the data transmission mode.

As described above, the problem with such high-speed data transmission is the data rates which cannot be rate-adapted with the present methods of the telecommunications systems. For example in the GSM system, such rates include all data rates that are not multiples of 9.6 Kbps.

This is solved in the invention by diving a high-speed user data signal in the transmitter into parallel traffic channels in such a way that the full capacity of as many traffic channels as possible is first used for the transmission of user data, whereafter the user data that is left over from these "full rate" traffic channels is transmitted on one "lower rate" traffic channel together with stuff bits. This method according to the invention will be described generally below.

Assume that the data transfer rate R_{user} required by a high-speed user data signal and arriving at a divider 82 in Figure 2 is in the range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of an individual traffic channel, and the integer $n \geq 2$. In such a case, the signal DATA IN requires n parallel traffic channels which are allocated by the fixed network (e.g. MSC). The divider 82 divides the data signal DATA IN into the transmission frames which will then be transmitted via the allocated parallel traffic channels in a manner illustrated in Figure 5. All the information bits in the transmission frames of traffic channels ch1, ch2 and ch(n-1) are user data bits, whereupon the transmission rate of the user data is R_{ch} on all these traffic channels. Therefore the traffic channels ch1, ch2, ch(n-1) carry the user data at the total transmission rate of $(n-1)*R_{ch}$. The information bits of the last traffic channel chn comprise user data bits DATA only in an amount corresponding to the user data transfer rate $R_{user}-(n-1)*R_{ch}$ left over from the other traffic channels, and the rest of the information bits are stuff bits FILL. The frames are transmitted via transmitters 80 and 81 to receivers 83 and 84, and combined in a combiner 85 to provide a high-speed user data signal DATA OUT. The

traffic channels between the divider 82 and the combiner 85 may then be standard rate-adapted and mutually identical traffic channels. Therefore, it is not necessary to introduce new rate adaptation into the mobile system separately for each standard user transmission rate.

The application of the present invention to the GSM system will be described below. It is then assumed that rate-adapted transparent full-rate 9.6 Kbps traffic channels are used as the parallel traffic channels, and V.110 frames of Figure 4 are transmitted on the traffic channels. A frame then comprises 48 information bits D1 to D48.

A few examples of the adaptation of high-speed data to such a V.110 frame of a GSM traffic channel will be examined below.

Example 1

Assume that the user data rate R_{user} = 56 Kbps, whereupon six parallel GSM traffic channels are needed (R_{ch} = 9.6 Kbps). The rate adaptation according to the invention may then be carried out as shown in Figure 6. All the 48 information bits D1 to D48 in each V.110 frame on traffic channels ch1, ch2, ch3, ch4 and ch5 carry user data, whereupon the user data rate on each of these channels is 9.6 Kbps. Therefore the total transmission rate of the channels ch1 to ch5 is 5*9.6 Kbps = 48 Kbps. The remaining user transmission rate is thus 56-48 Kbps = 8 Kbps, which is transmitted on the last traffic channel ch6. This is carried out in such a way that 40 information bits (e.g. D1 to D40) in each V.110 frame on traffic channel ch6 carry user data bits and 8 information bits (e.g. D41 to D48) carry stuff bits. In this manner, a 56 Kbps signal can be transmitted through six GSM traffic channels.

Example 2

Assume that the user data rate R_{user} = 14.4 Kbps. Two traffic channels (R_{ch} = 9.6 Kbps) are then needed. In such a case, all the information bits D1 to D48 of the V.110 frame on the first traffic channel carry user data bits, whereupon the transmission rate is 9.6 Kbps. The remaining data rate, i.e. 14.4-9.6 Kbps = 4.8 Kbps, is adapted to the second traffic channel in such a way that 24 information bits (e.g. D1 to D24) in each V.110 frame carry user data and 24 information bits (e.g. D25 to D48) carry stuff bits.

Example 3

Assume that the user data rate R_{user} = 26.4 Kbps, whereupon three traffic channels (R_{ch} = 9.6 Kbps) are needed. In such a case, all the information bits D1 to D48 in the V.110 frames of two traffic channels carry user data. The total transmission rate of these two traffic channels is then 19.2 Kbps. The remaining user data rate, i.e. 26.4-19.2 Kbps = 7.2 Kbps, is adapted to a third channel in such a way that 36 information bits (e.g. D1 to D36) of each V.110 frame carry user data and 12 information bits (e.g. D37 to D48) carry stuff bits.

Example 4

Assume that the user data rate R_{user} = 38.4 Kbps, whereupon four traffic channels (R_{ch} = 9.6 Kbps) are needed. Since the user data rate is divided evenly into four traffic channels in such a way that the total capacity of all the traffic channels is used, no stuff bits being needed on any traffic channel.

Even though the invention is described above with reference to certain embodiments, it should be understood, however, that the description is only exemplary and it may be varied and modified without

deviating from the spirit and scope of the invention defined in the appended claims.

Claims

1. A method for high-speed data transmission in a digital mobile system, said method comprising a step of

transmitting data over the radio path between a mobile station and a fixed mobile network o: a rate-adapted traffic channel allocated to the mobile :ation, c h a r a c t e r i z e d by further steps of

allocating n parallel rate-adapted traffic channels to a high-speed user data signal, which requires a data rate R_{user} within a range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of any one of said traffic channels, and n=2,3,...,

dividing the high-speed user data signal into transmission frames for transmission via said parallel traffic channels in such a way that all the information bits in the transmission frames of n-1 traffic channels carry user data bits, and the user data transfer rate of each of said n-1 traffic channels being R_{ch}, and a number of the information bits carrying user data bits in transmission frames of said nth traffic channel corresponds to the user data transfer rate $R_{user}-(n-1)*R_{ch}$ left over from the other n-1 traffic channels, and the remaining information bits in the transmission frames of said nth traffic channel carry stuff bits.

2. A method according to claim 1, c h a r a c t e r i z e d by transmitting V.110 frames according to a CCITT recommendation on the parallel traffic channels.

3. A digital mobile system wherein a mobile station (MS) and a fixed mobile network (BTS, BSC, MSC) comprise a data transmitter (31, 32, 82) and a data receiver (31, 32, 81) which are capable of data

transmission over the radio path on a traffic channel allocated to the mobile station, characterized in that

the fixed mobile network (BTS, BSC, MSC) is arranged to allocate n parallel rate-adapted traffic channels to a high-speed user data signal which requires a data transfer rate R_{user} that is in the range $(n-1)*R_{ch}<R_{user}<n*R_{ch}$, wherein R_{ch} is the maximum transmission rate of an individual traffic channel and $n=2,3,...,$

the data transmitters (31, 32, 82) are arranged to divide the high-speed user data signal into transmission frames for transmission via said parallel traffic channels in such a way that all the information bits in the transmission frames of n-1 traffic channels carry user data bits, and the user data transfer rate of each of said n-1 traffic channel being R_{ch}, and a number of the information bits carrying user data bits in the transmission frames of the nth traffic channel corresponds to the user data transfer rate $R_{user}-(n-1)*R_{ch}$ left over from the other n-1 traffic channels, and the remaining information bits in the transmission frames of said nth traffic channel carry stuff bits.

4. A system according to claim 3, characterized in that the traffic channels are V.110 rate-adapted channels and the transmission frames are V.110 frames according to a CCITT recommendation.

5. A system according to claim 3 or 4, characterized in that the maximum transmission rate R_{ch} of the traffic channel is 9.6 Kbps.

6. A system according to claim 3, 4 or 5, characterized in that the system is a GSM mobile system or a mobile system based thereon.

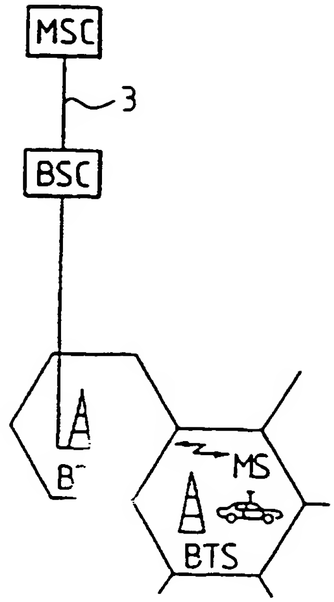


FIG. 1

OCTET NO.	BIT NUMBER							
	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	1	D1	D2	D3	D4	D5	D6	S1
2	1	D7	D8	D9	D10	D11	D12	X
3	1	D13	D14	D15	D16	D17	D18	S3
4	1	D19	D20	D21	D22	D23	D24	S4
5	1	E1	E2	E3	E4	E5	E6	E7
6	1	D25	D26	D27	D28	D29	D30	S6
7	1	D31	D32	D33	D34	D35	D36	X
8	1	D37	D38	D39	D40	D41	D42	S8
9	1	D43	D44	D45	D46	D47	D48	S9

FIG. 4

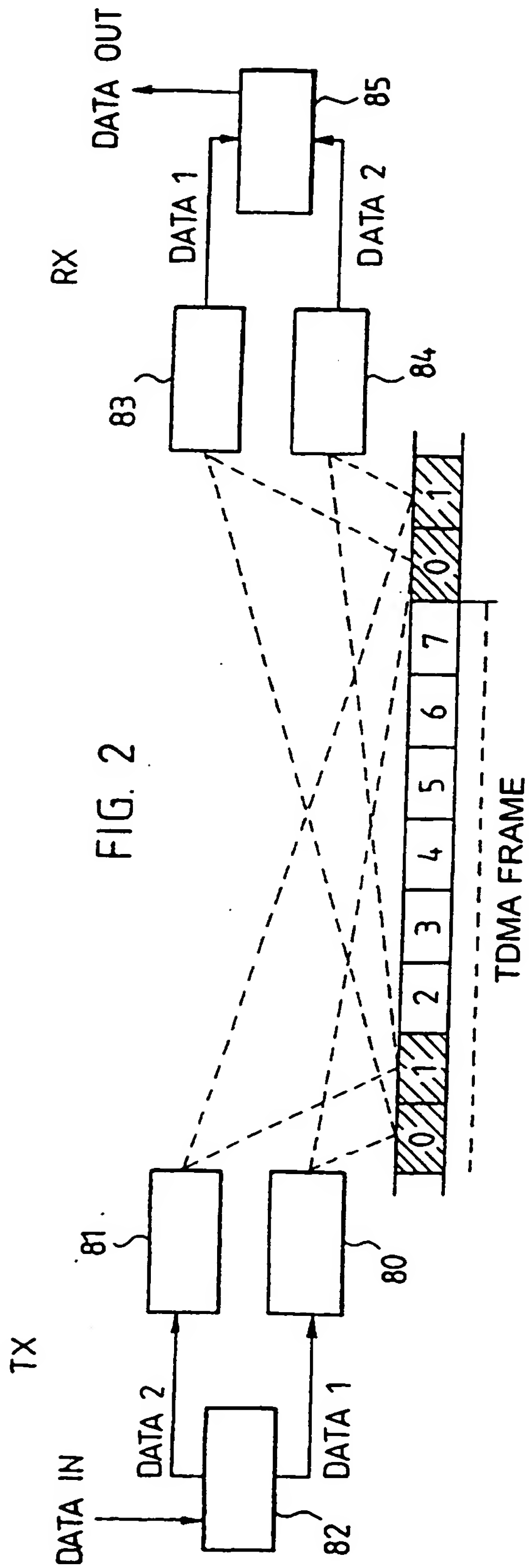

DATA OUT
85
DATA 1
DATA 2
RX
83
84
0
1
7
6
5
4
3
2
1
0
TDMA FRAME
81
80
TX
DATA 2
DATA 1
DATA IN
82

FIG. 2

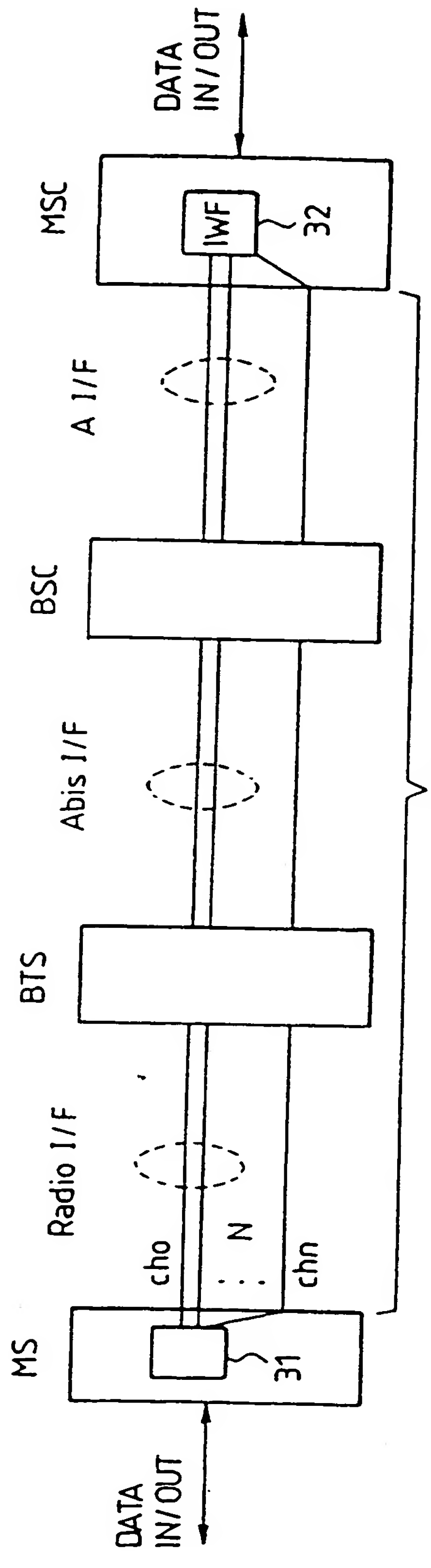

DATA IN/OUT
MSC
IWF
32
A I/F
BSC
Abis I/F
V.110
BTS
Radio I/F
cho
N
chn
MS
31
DATA IN/OUT

FIG. 3

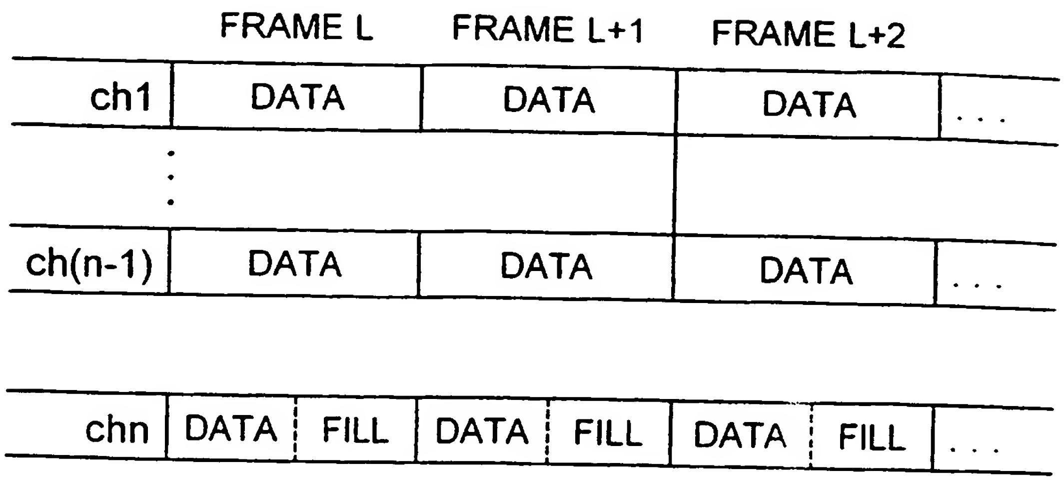

FRAME L
FRAME L+1
FRAME L+2
ch1
DATA
DATA
DATA
. . .
ch(n-1)
DATA
DATA
DATA
. . .
chn
DATA
FILL
DATA
FILL
DATA
FILL
. . .

FIG. 5

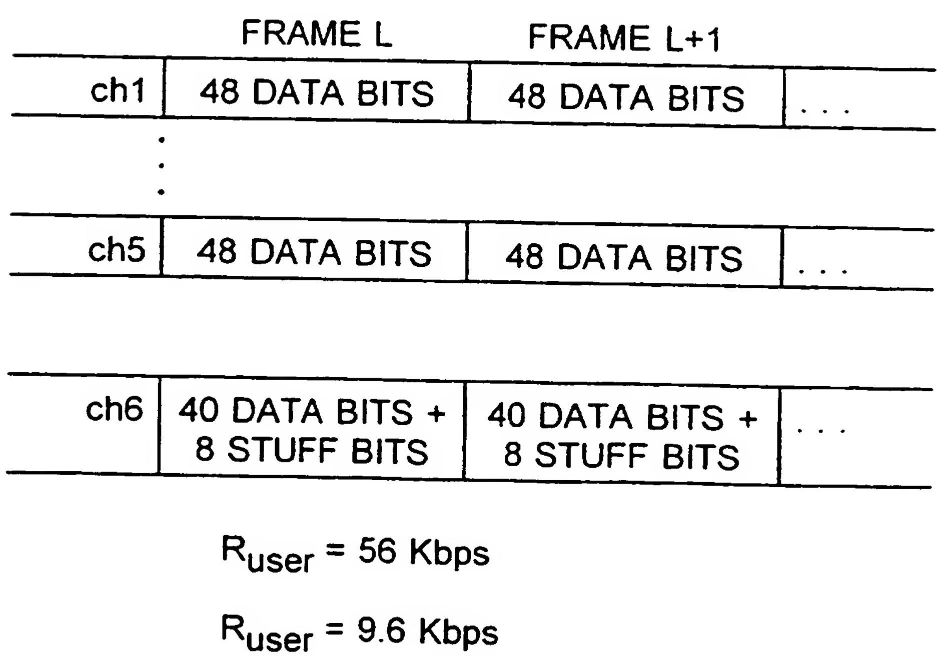

FRAME L
FRAME L+1
ch1
48 DATA BITS
48 DATA BITS
. . .
ch5
48 DATA BITS
48 DATA BITS
. . .
ch6
40 DATA BITS + 8 STUFF BITS
40 DATA BITS + 8 STUFF BITS
. . .
R user = 56 Kbps
R user = 9.6 Kbps

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00134

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04J 3/16, H04B 7/26 // H04Q 7/22
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04J, H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0534493 A2 (FUJITSU LIMITED), 31 March 1993 (31.03.93), column 1, line 5 - line 12; column 4, line 49 - column 5, line 38, figure 7 --	1,3
Y	WO 9008434 A1 (MOTOROLA, INC.), 26 July 1990 (26.07.90), page 1; page 3, line 14 - line 30 --	1,3
A	EP 0382363 A2 (DATA GENERAL CORPORATION), 16 August 1990 (16.08.90), column 2, line 35 - column 3, line 23 --	1,3
A	US 5005170 A (D.R. NELSON), 2 April 1991 (02.04.91), column 2, line 17 - column 3, linè 42 --	1,3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
6 August 1996

Date of mailing of the international search report
08-08-1996

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer
Kenneth Ahrengart
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00134

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9114319 A1 (NEWBRIDGE NETWORKS CORPORATION), 19 Sept 1991 (19.09.91), abstract -- --------	1,3

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/96

International application No.
PCT/FI 96/00134

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0534493	31/03/93	CA-A- 2079010	28/03/93
		JP-A- 5091081	09/04/93
WO-A1- 9008434	26/07/90	AU-B,B- 626642	06/08/92
		AU-A- 5043790	13/08/90
		CA-A,C- 2005507	23/07/90
		DE-D- 68926123	00/00/00
		EP-A,A,A 0454776	06/11/91
		US-A- 4942570	17/07/90
EP-A2- 0382363	16/08/90	AU-A- 4788490	16/08/90
		CA-A- 1336450	25/07/95
		DE-D,T- 69022440	09/05/96
		JP-A- 2291735	03/12/90
		US-A- 4965787	23/10/90
US-A- 5005170	02/04/91	NONE	
WO-A1- 9114319	19/09/91	CA-A- 2012361	16/09/91
		DE-D,T- 69113451	02/05/96
		EP-A,A,B 0519954	30/12/92
		US-A- 5351239	27/09/94
		CA-A- 2025866	21/03/92